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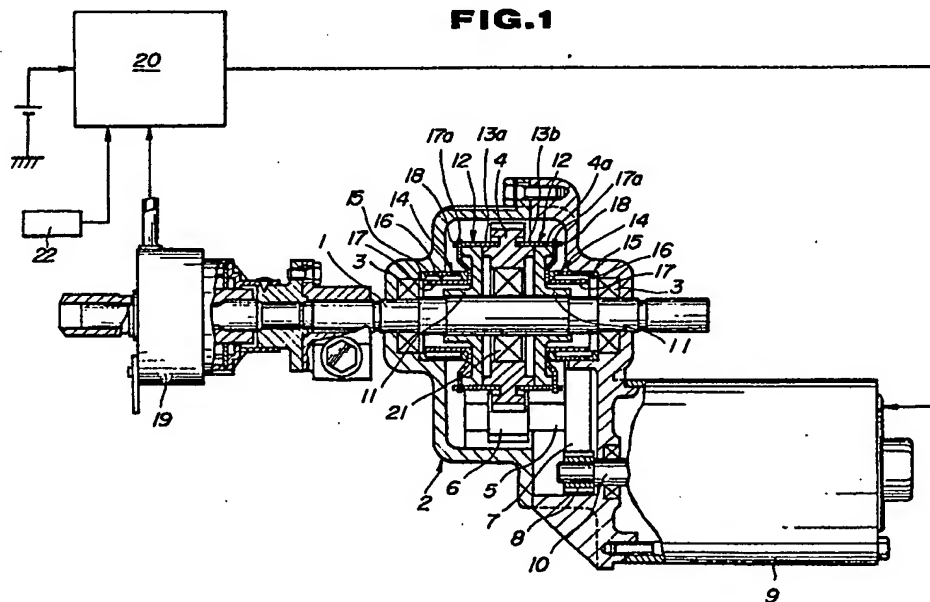
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54 **Electric motor powered power steering arrangement with feature of decoupling motor from steering shaft.**

57 The power steering arrangement employs a mechanical one-way clutch (14) which is designed for coupling an electric motor (9) with a steering shaft (1) for transmitting driving torque of the motor while

the driving torque is supplied thereto from the electric motor and for decoupling the electric motor from the steering shaft when the driving torque is not supplied from the electric motor.

**FIG.1**



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## ELECTRIC MOTOR POWERED POWER STEERING ARRANGEMENT WITH FEATURE OF DECOUPLING MOTOR FROM STEERING SHAFT

The present invention relates generally to a power steering arrangement for an automotive vehicle. More specifically, the invention relates to a power steering arrangement which employs an electric motor as an assisting power source.

One example of conventionally proposed electrically powered power steering arrangement has been disclosed in Japanese Patent First (unexamined) Publication (Tokkai) Shows 62-273165. In the disclosed arrangement, an electric motor is coupled with a steering shaft via a gear. An electromagnetic clutch is interposed between the motor and the gear for establishing and blocking torque transmission between the motor and the gear.

In such construction, relatively large capacity of electromagnetic clutch is required for satisfactorily controlling transmission of the driving torque of the electric motor. Therefore, the overall size and weight of the steering arrangement becomes bulky and heavy. Furthermore, in order to control the clutch externally, complicated electric wiring is required, making the production cost of the arrangement unacceptably high.

Therefore, it is an object of the present invention to provide an electric motor powered power steering arrangement which can solve the drawback in the prior art.

In order to accomplish aforementioned and other objects, a power steering arrangement, according to the present invention, employs a mechanical one-way clutch which is designed for coupling an electric motor with a steering shaft for transmitting driving torque of the motor while the driving torque is supplied thereto from the electric motor and for decoupling the electric motor from the steering shaft when the driving torque is not supplied from the electric motor.

According to one aspect of the invention, an electric motor powered power steering arrangement for an automotive vehicle, comprises: a steering shaft which is connected to a steering mechanism for causing toe angle change of a vehicular wheel, the steering shaft being connected to a manually operable means for entry of steering demand;

an electric motor responsive to a control signal for generating a driving torque;

a gear train comprising a plurality of gears for transmitting driving torque generated by the electric motor; and

a mechanical torque transmission control means, associated with the gear train, for permitting transmission of the driving torque of the electric motor

to the steering shaft and blocking torque transmission from the steering shaft to the electric motor.

The mechanical torque transmission control means may comprise a mechanical clutch mechanism which is engaged in response to the driving torque generated by the electric motor and which is maintained in disengaged position during absence of the driving torque of the electric motor. In such case, the gear train comprises a main gear rotatably supported on the steering shaft for rotation therewith and designed to be driven by the driving torque of the electric motor, a clutch wheel rigidly secured to the steering shaft for rotation therewith, and the mechanical clutch mechanism includes a one-way clutch for establishing engagement between the main gear and the clutch wheel for co-rotation with each other in response to driving torque supplied from the motor and for maintaining the steering shaft free from the main gear while the driving torque from the electric motor is absent.

In the preferred construction, the clutch mechanism comprises a first clutch component active for establishing driving torque transmission from the electric motor to the steering shaft in a first steering direction and a second clutch component active for establishing driving torque transmission from the electric motor to the steering shaft in a second steering direction. In such case, the gear train comprises a main gear rotatably supported on the steering shaft for rotation therewith and designed to be driven by the driving torque of the electric motor, and the first clutch component includes a first clutch wheel rigidly secured to the steering shaft for rotation therewith, and a first one-way clutch for establishing engagement between the main gear and the clutch wheel for co-rotation with each other in response to driving torque in the first steering direction supplied from the motor and for maintaining the steering shaft free from the main gear while the driving torque in the first steering direction from the electric motor is absent, and the second clutch component includes a second clutch wheel rigidly secured to the steering shaft for rotation therewith, and a second one-way clutch for establishing engagement between the main gear and the clutch wheel for co-rotation with each other in response to driving torque in the second steering direction supplied from the motor and for maintaining the steering shaft free from the main gear while the driving torque in the second steering direction from the electric motor is absent.

The present invention will be understood more fully from the detailed description given herebelow

and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to limit the invention to the specific embodiment but are for explanation and understanding only.

In the drawings:

sole drawing is a section of the preferred embodiment of an electric motor powered power steering arrangement according to the present invention.

Referring now to the drawings, the preferred embodiment of an electric motor powered power steering arrangement, according to the present invention, includes a steering shaft 1. The steering shaft 1 is rotatably supported in a housing 2 by means of a bearing 3. A main gear 4 is supported on the steering shaft 1 by means of a bearing 21 in such a manner that it can cause relative angular displacement with respect to the steering shaft.

A gear 6 is meshed with the main gear 4 and rotatably supported on a counter shaft 5. Another gear 7 is also rotatably mounted on the counter shaft 5. The gear 7 meshes with a motor gear 8 which is secured on a motor output shaft 10 of an electric motor 9. The gears 4, 6, 7 and 8 form a gear trains for transmitting motor driving torque to the steering shaft 1. Therefore, the output torque of the motor 9 is transmitted to the steering shaft 1 via the gear train.

A pair of clutch wheels 11 are arranged opposing to both of axial ends of the main gear 4. These clutch wheels 11 are rigidly secured on the steering shaft 1 for rotation therewith. Between each of the clutch wheels 11 and the main gear 4, a mechanical clutch 12 is provided. The mechanical clutch 12 comprises a coil spring 13a or 13b secured on the boss section 4a of the main gear 4 and the clutch wheel 11. A one-way clutch 14 is provided for restricting movement of the associated one of coil spring 13a and 13b. Each of the one-way clutches 14 has an outer holder 15 engaged with a holder receptacle recess 16 and an inner holder 17. The inner holder 17 has a flange 17a having the outer end engaged with the outer end 18 of the coil spring 13a and 13b. The flange 17a of the inner holder 17 thus prevents the associated one of the coil springs 13a and 13b from rotating in winding direction and permits the coil spring to rotate in unwinding direction.

The mechanical clutch 12 thus constructed operates as follows. Assuming that the steering shaft 1 is operated to rotate in right, the coil spring 13b is rotated in unwinding direction to expand the diameter thereof. On the other hand, the coil spring 13a is prevented from rotating in winding direction. Therefore, at this time, the coil spring 13a is not active for establishing engagement between the boss section 4a of the main gear 4 and the clutch wheel 11. On the other hand, assuming that the

steering shaft 1 is operated to rotate in left, the coil spring 13a is rotated in unwinding direction to expand the diameter thereof. On the other hand, the coil spring 13b is prevented from rotating in winding direction. Therefore, at this time, the coil spring 13b is not active for establishing engagement between the boss section 4a of the main gear 4 and the clutch wheel 11. Therefore, in either case, the steering shaft 1 and the main gear 4 are held in decoupled position so as to permit free rotation relative to each other.

On the other hand, when the motor is driven for providing right hand driving torque, the coil spring 13b is driven in winding direction for coupling the main gear 4 and the clutch wheel 11. At the same time, the coil spring 13a is driven in unwinding direction. Therefore, the right handing driving torque is transmitted to the steering shaft via the interengaged main gear 4 and the clutch wheel 11. When the motor is driven for providing left hand driving torque, the coil spring 13a is driven in winding direction for coupling the main gear 4 and the clutch wheel 11. At the same time, the coil spring 13b is driven in unwinding direction. Therefore, the right handing driving torque is transmitted to the steering shaft via the interengaged main gear 4 and the clutch wheel 11.

A torque sensor 19 is provided on the steering shaft 1 in series to the housing. The torque sensor 19 is designed for monitoring steering torque to supply a steering torque indicative signal for a control unit 20. The control unit 20 also receives a vehicle speed indicative signal from a vehicle speed sensor 22. The control unit 20 derives a control current to be supplied to the electric motor 9 on the basis of the steering torque indicative signal and the vehicle speed indicative signal. The operation of the electric motor 9 is thus controlled by the control current supplied from the control unit.

With the construction set forth above, when the steering operation is made by a driver and thus the steering shaft is rotated, the operational torque entered through a steering wheel is detected by the torque sensor 19. As set forth above, the torque sensor supplies the steering torque indicative signal to the control unit 20. At the same time, the control unit 20 receives the vehicle speed indicative signal from the vehicle speed sensor 22. The control unit 20 thus feeds the control current derived on the basis of the steering torque indicative signal and the vehicle speed indicative signal, to the motor 9. With control current, the motor 9 is driven to establish interengagement of the main gear 4 and one of the clutch wheels 11. Therefore, the driving torque of the motor 9 is applied to the steering shaft 1 as the steering assist torque. On the other hand, the operational torque applied to

the steering shaft 1 via the steering wheel will not cause interengagement of the main gear 4 and the clutch wheel 11 as long as the main gear is not rotatingly driven by the driving torque supplied from the motor. Therefore, the motor will never receive the manually received driving torque.

With the construction set forth above, since the mechanism for coupling and decoupling the electric motor and the steering shaft can be formed by mechanical clutch mechanism, the size of the clutch mechanism can be smaller than that of an electromagnetic clutch. Also, since the clutch mechanism in the shown embodiment of the power steering arrangement can be operated in purely mechanical fashion depending upon the power transmitting direction, no wiring for controlling the clutch mechanism is required.

Therefore, a compact, light-weight and low-cost electric power steering arrangement can be formulated.

While the present invention has been disclosed in terms of the preferred embodiment in order to facilitate better understanding of the invention, it should be appreciated that the invention can be embodied in various ways without departing from the principle of the invention. Therefore, the invention should be understood to include all possible embodiments and modifications to the shown embodiments which can be embodied without departing from the principle of the invention set out in the appended claims.

## Claims

1. An electric motor powered power steering arrangement for an automotive vehicle comprising: a steering shaft (1) which is connected to a steering mechanism for causing toe angle change of a vehicular wheel, the steering shaft (1) being connected to manually operable means for entry of steering demand; an electric motor (9) responsive to a control signal for generating driving torque; a gear train comprising a plurality of gears (4,6,7,8) for transmitting driving torque generated by the electric motor (9); and a mechanical torque transmission control means, associated with the said gear train, for permitting transmission of the driving torque of the electric motor (9) to the steering shaft (1) and blocking torque transmission from the steering shaft (1) to the electric motor (9).

2. A power steering arrangement as claimed in claim 1, wherein the mechanical torque transmission control means comprises a mechanical clutch mechanism (12) which is engaged in response to the driving torque generated by the electric motor

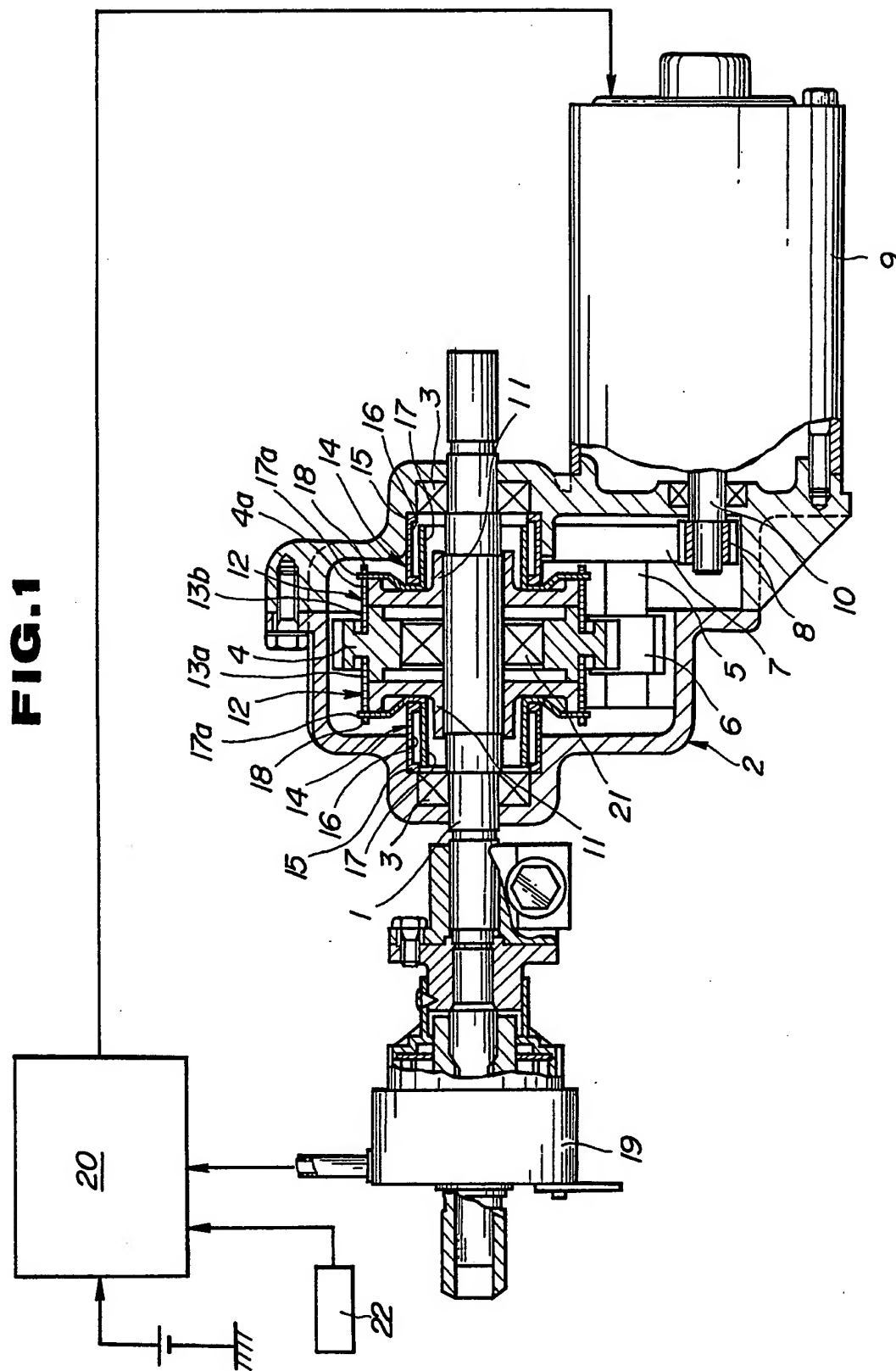
(9) and which is maintained in disengaged position during absence of such driving torque.

3. A power steering arrangement as claimed in claim 2, wherein the gear train comprises a main gear (4), rotatably supported on the steering shaft (1) and arranged to be driven by the driving torque of the electric motor (9), a clutch wheel (11) is secured to the steering shaft (1) for rotation therewith, and the mechanical clutch mechanism (12) includes a one-way clutch (14) for establishing engagement between the main gear (4) and the clutch wheel (11) for co-rotation with each other in response to driving torque supplied from the electric motor (9) and for maintaining the steering shaft (1) free from the main gear (4) while driving torque from the electric motor is absent.

4. A power steering arrangement as claimed in claim 2 or 3, wherein the mechanical clutch mechanism comprises a first clutch component (12) active for establishing driving torque transmission from the electric motor (9) to the steering shaft (1) in a first steering direction and a second clutch component (12) active for establishing driving torque transmission from the electric motor (9) to the steering shaft (1) in a second steering direction.

5. A power steering arrangement as claimed in claim 4, wherein the gear train comprises a main gear (4) rotatably supported on the steering shaft (1) and arranged to be driven by the driving torque of the electric motor (9); the first clutch component (12) includes a first clutch wheel (11) secured to the steering shaft (1) for rotation therewith, and a first one-way clutch (14) for establishing engagement between the main gear (4) and the first clutch wheel (11) for co-rotation with each other in response to driving torque in the said first steering direction supplied from the electric motor and for maintaining the steering shaft (11) free from the main gear (4) while driving torque in the said first steering direction from the electric motor is absent; and the second clutch component (12) includes a second clutch wheel (11) secured to the steering shaft (1) for rotation therewith, and a second one-way clutch (14) for establishing engagement between the main gear (4) and the second clutch wheel (11) for co-rotation with each other in response to driving torque in the said second steering direction supplied from the electric motor and for maintaining the steering wheel (1) free from the main gear (4) while driving torque in the said second direction from the electric motor is absent.

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# EUROPEAN SEARCH REPORT

Application Number

EP 90 30 0568

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 339 520 (BOSCH GMBH) * whole document *	1,2,4	B 62 D 5/04
X	DE-A-2 247 135 (BOSCH GMBH) * page 5, line 12 - page 6, line 28; figure 1 *	1-3	
X	EP-A-0 081 025 (CITROEN et al.) * page 12, lines 4-37; figure 4 *	1-3	
X	EP-A-0 051 515 (CITROEN et al.) * page 7, lines 5-16; figures 2,3 *	1-3	
X	WO-A-8 400 199 (P. NORTON) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 62 D
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 11-04-1990	Examiner KRIEGER P O
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